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ASSIGNMENT BOOKLET
SCN3260 Physics 30
Module 6 Assignment

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Date Assignment Submitted: _____ Time Spent on Assignment: _____	(If label is missing or incorrect) Student File Number: _____ Module Number: _____

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Assigned Teacher: _____

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_____
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- Has your work been reread to ensure accuracy in spelling and details?
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Physics 30

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Quantum Theory of Light

Module 6

Assignment Booklet

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FOR TEACHER'S USE ONLY

Summary

	Total Possible Marks	Your Mark
Lesson 1 Assignment	23	
Lesson 2 Assignment	30	
Lesson 3 Assignment	25	

Teacher's Comments

Physics 30
Module 6: Quantum Theory of Light
Assignment Booklet
ISBN 978-0-7741-3206-0

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This document is intended for	
Students	✓
Teachers	✓
Administrators	
Home Instructors	
General Public	
Other	

You may find the following Internet sites useful:

- Alberta Education, **http://www.education.gov.ab.ca**
- Learning Resources Centre, **http://www.lrc.education.gov.ab.ca**
- Tools4Teachers, **http://www.tools4teachers.ca**

Exploring the electronic information superhighway can be educational and entertaining. However, be aware that these computer networks are not censored. Students may unintentionally or purposely find articles on the Internet that may be offensive or inappropriate. As well, the sources of information are not always cited and the content may not be accurate. Therefore, students may wish to confirm facts with a second source.

(23 marks)

MODULE 6: LESSON 1 ASSIGNMENT

This Module 6: Lesson 1 Assignment is worth 23 marks. The value of each assignment and each question is stated in the left margin.

(1 marks) **A 1.** Why couldn't classical physics explain blackbody radiation curves?

(3 marks) **A 2.** What is the frequency of a 13.0-eV photon?

(3 marks) **A 3.** What is the wavelength of a 4.30×10^{-19}-J photon?

(3 marks) **A 4.** How many photons with a frequency of 532 nm are released each second by a 5.0-mW laser?

(3 marks) **A 5.** As a safety precaution when working with lasers, scientists wear red-coloured glasses that will block all colours but red. Why is red light safer than blue light? Why is a red laser safer than a blue laser?

(3 marks) **A 6.** A person lives near a 50-kW radio tower. Why is it safe to live near the high-power radio tower but dangerous to be exposed to an X-ray machine that uses 7.5 kW?

(3 marks) **A 7.** Why did the introduction of the photon effectively end classical physics? What does this mean for the Christiaan Huygens theory that light is a series of waves and Thomas Young's double-slit experiment?

(4 marks) **D 3.** Read the answers from two other students for D 2 and improve your own answer. Copy your answer into the space below. Explain what you learned from reading the other students' answers and if or how you changed your own solution. You will be marked according to the following Discussion Scoring Guide.

DISCUSSION SCORING GUIDE

Principles involved: energy of a photon and power

Criteria	Level 1 (Below Standard)	Level 2 (Approaching Standard)	Level 3 (Standard)	Level 4 (Above Standard)
Knowledge				
Demonstrates understanding of the situation, physics principles and technology, and their connections.	Demonstrates a vague and sometimes incorrect understanding of the physics principles involved. Obvious irrelevant or missing information.	Demonstrates a basic understanding of the physics principles involved. May exhibit minor mistakes or vague information or application to the situation.	Demonstrates a good understanding of the physics principles involved and applies them properly to the given situation. All necessary information is given.	Demonstrates a superior understanding of the physics principles involved and their application to the situation. All applications are considered in detail.
Reflection				
The post shows reflection on one's own and other students' work. Contributes to the group discussion.	Does not make an effort to participate. Seems indifferent to discussion.	Occasionally makes meaningful reflections on the group's efforts or discussions. Marginal effort is shown to become involved with the group or discussion.	Frequently makes meaningful reflections on the group's efforts and presents relevant viewpoints for consideration by the group. Interacts freely with group members.	Regularly attempts to motivate the group discussion and delve deeper into concepts. Interacts freely and encourages all group members.

Content and presentation of discussion summary				
The information is logically arranged in a clear and concise manner.	The information is poorly organized with many concepts implied. Irrelevant or rambling sentences make reading difficult.	The information is somewhat organized with implied concepts. Excessive words or awkward sentences are used, which hinder reading.	The information is well-organized and logically arranged. All concepts are explicitly explained. There are a few awkward but understandable sentences.	The information is well-organized and very easy to understand. Well-worded sentences make reading pleasurable.

(30 marks)

MODULE 6: LESSON 2 ASSIGNMENT

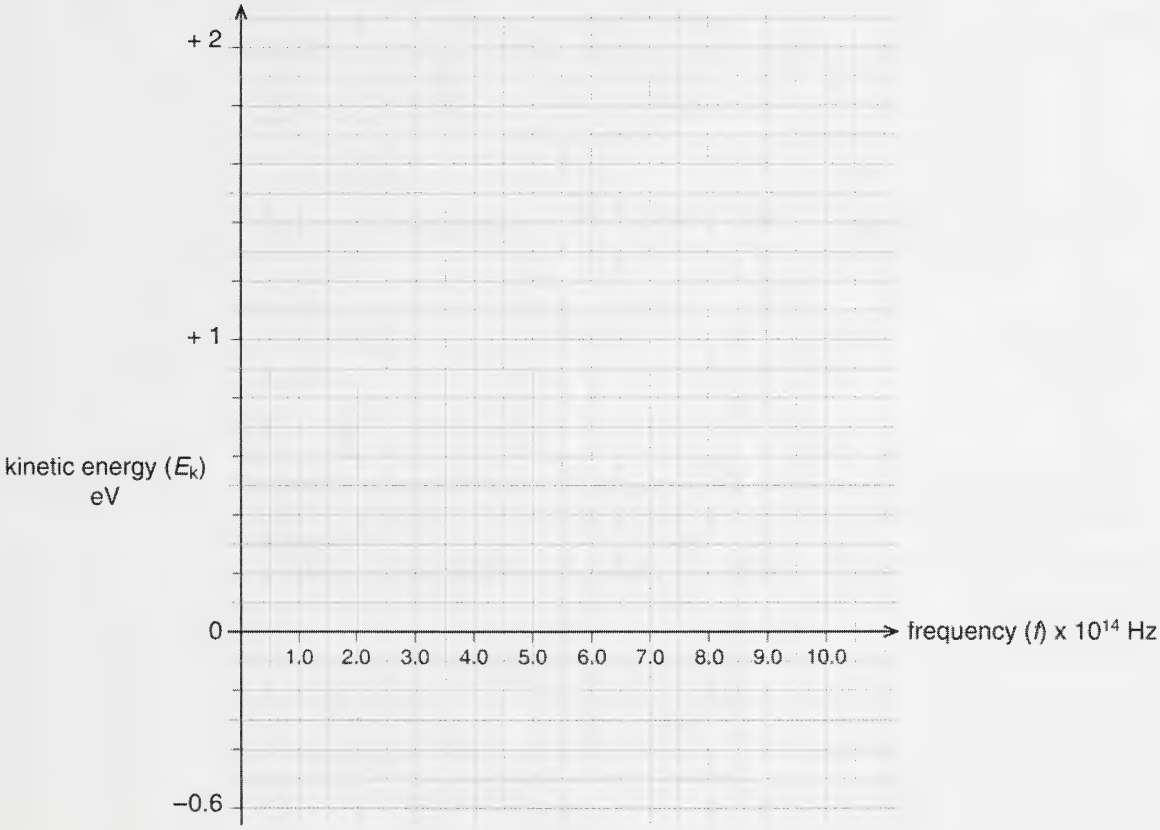
This Module 6: Lesson 2 Assignment is worth 30 marks. The value of each assignment and each question is stated in the left margin.

While conducting research into the design of a light sensor, scientists measure the kinetic energy of photoelectrons that have been ejected from an unknown metal surface. The metal is exposed to various frequencies of EMR and the stopping voltage is measured to obtain the kinetic energy of the photoelectrons. The following data is obtained.

Incident EMR Frequency ($\times 10^{14}$ Hz)	Kinetic Energy of Photoelectrons (eV)
6.0	0.38
7.0	0.80
8.0	1.20
9.0	1.63
10.0	2.04

(3 marks) **A 1.** Using this data, plot a kinetic energy versus frequency graph and use it to answer questions A 2 to A 5. A graph for you to complete is provided on the next page.

Electron Kinetic Energy vs. Frequency of Incident EMR



(2 marks) **A 2.** According to your graph, what is the threshold frequency of the unknown metal? Label it on your graph.

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_____

_____

(3 marks) **A 3.** Determine the work function of the unknown metal.

(1 marks) **A 4.** Using Table 14.1 on page 712 of your textbook, identify the unknown metal.

_____

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_____

(2 marks) **A 5.** Using your graph, determine the experimental value for Planck's constant (in eV•s). Label this value on your graph.

(3 marks) **A 6.** What is the energy of a photon that has a wavelength of 460 nm?

(3 marks) **A 7.** A photoelectric surface has a work function of 2.00 eV. What is the threshold frequency of this surface?

(3 marks) **A 8.** A photon of frequency 8.2×10^{15} Hz is incident upon a photoelectric apparatus containing a metal whose threshold frequency is 3.6×10^{15} Hz. What is the stopping voltage?

(3 marks) **A 9.** Electrons are ejected from a photoelectric cell with a maximum kinetic energy of 1.20 eV. If the incident light has a wavelength of 410 nm, what is the work function of the cell?

(3 marks) **A 10.** Light with a wavelength of 425 nm falls on a photoelectric surface that has a work function of 2.0 eV. What is the maximum speed of any emitted photoelectrons?

D 1. You are asked to explain the photoelectric effect in terms of energy to a student who missed the class. In your explanation, start with the energy of the incident EMR photons and finish with the energy of the stopping voltage. Make sure to include the following terms in your answer: threshold frequency, light intensity, photoelectron current, work function, photoelectron kinetic energy, and stopping voltage. Post your answer to the discussion area.

(4 marks) **D 2.** Read the answers to D 1 of at least two other students. Revise your answer from D 1 and include any changes you made and how they improved your answer. You will be marked according to the following Discussion Scoring Guide.

DISCUSSION SCORING GUIDE

Principles involved: Conservation of energy, light energy, electrical energy and voltage				
Criteria	**Level 1 (Below Standard)**	**Level 2 (Approaching Standard)**	**Level 3 (Standard)**	**Level 4 (Above Standard)**
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There are more lines on the following page.

(25 marks)

MODULE 6: LESSON 3 ASSIGNMENT

This Module 6: Lesson 3 Assignment is worth 25 marks. The value of each assignment and each question is stated in the left margin.

(2 marks) **A 1.** What is the difference between the photoelectric effect and the Compton effect?

(2 marks) **A 2.** How does the Compton effect show the wave-particle duality of light?

(4 marks) **A 3.** An X-ray with a frequency of 3.74×10^{20} Hz is incident on a thin piece of metal. The lower frequency X-ray on the other side is observed deflected at 48°. What is the frequency of the deflected X-ray?

There is more space on the following page.

(4 marks) **A 4.** The scientist changes the frequency of the incident X-ray to 4.50×10^{20} Hz and measures the deflected X-ray frequency of 4.32×10^{20} Hz. What is the angle of deflection?

(1 mark) **A 5.** How did de Broglie's wave equation show that energy and matter are similar?

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(3 marks) **A 6.** A stationary hydrogen atom with a mass of 1.67×10^{-27} kg absorbs a photon of light with 10.2 eV. What is the velocity of the hydrogen atom after absorbing the photon in a perfectly inelastic collision?

(3 marks) **A 7.** If you performed Young's experiment with high-speed electrons instead of light, what would the results look like? How does this support the wave or particle model?

(2 marks) **A 8.** What does Heisenberg's uncertainty principle mean about physicists' attempts to measure the size of the electron?

There are more lines on the following page.

(4 marks) **D 2.** Read the solutions that two other students have posted. Use what you learn from their solutions to improve your own solution. Include comments on what you learned from the other two submissions. You will be graded according to the following Discussion Scoring Guide.

DISCUSSION SCORING GUIDE

Principles involved: Wave nature of matter, Heisenberg's uncertainty principle				
Criteria	**Level 1 (Below Standard)**	**Level 2 (Approaching Standard)**	**Level 3 (Standard)**	**Level 4 (Above Standard)**
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There are lines for your answer on the following page.

Once you have completed all of the questions, submit your work to your teacher.